

**WHAT IS CLAIMED IS:**

1. A wavefront sensor for determining the wave aberrations of the living eye, said wavefront sensor receiving a reflected point source image of the retina of said eye, comprising:

a plurality of lenslets which form a lenslet array for receiving said reflected point source image of said retina and for creating an aerial image of the retinal point source; said lenslet array being configured such that it is capable of providing resolution for at least fifth order aberrations;

a camera located adjacent to said lenslet array for viewing said aerial image of the retinal point source formed on each of said plurality of lenslets of said lenslet array; and

a digital data processor connected to receive video output signals from said camera and for converting said video output signals to digital signals representative of said retinal point source aerial images, said digital data processor further calculating the wave aberrations of said eye so as to include at least fifth order modes, using said representative digital signals.

2. The wavefront sensor of claim 1, further including a polarizer through which said reflected point source image of said retina passes prior to being received by said plurality of lenslets.

3. The wavefront sensor of claim 1, further including a compensating optical device connected to said digital data processor, such that, under control of said digital data

processor, said compensating optical device is adjusted for providing wavefront compensation for said wave aberrations of said eye.

4. The wavefront sensor of claim 3, further including a polarizer filter through which said reflected point source image of said retina passes prior to being received by said plurality of lenslets.

5. The wavefront sensor of claim 1, wherein said lenslet array is capable of providing resolution of up to at least tenth order wave aberrations.

6. The wavefront sensor of claim 1, wherein said lenslet array is a Hartmann-Shack wavefront sensor having up to 217 lenslets.

7. The wavefront sensor of claim 1, further including at least one of a contact and intraocular lens fabrication system connected to receive the calculated wave aberrations from said digital data processor for fabricating at least one contact or intraocular lens to provide wavefront compensation for said wave aberrations of said living eye.

8. The wavefront sensor of claim 1, further including surgical equipment connected to receive the calculated wave aberrations from said digital data processor for use in performing surgery on said living eye to provide wavefront compensation for said wave aberrations of said living eye.

9. The apparatus of claim 3, wherein said compensating optical device is one of a deformable mirror, liquid crystal device, micro-machined mirror and bimorph mirror.

10. Apparatus for fabricating contact or intraocular lenses to correct for at least the third order wave aberrations of the living eye, comprising;

means for generating a reflected point source image of a retina of said living eye;

means for receiving said reflected point source image and for converting said point source image to corresponding digital signals;

a digital data processor for calculating wave aberrations of the eye so as to include at least third order modes, using said digital signals; and

at least one of a contact lens and intraocular fabrication system connected to receive the calculated wave aberrations from said digital data processor for fabricating at least one contact or intraocular lens to provide wavefront compensation for said at least third order wave aberrations of said living eye.

11. The apparatus of claim 10, wherein said means for generating comprises a plurality of lenslets which form a lenslet array for receiving said reflected point source image of said retina, said lenslet array being configured such that it is capable of providing resolution for at least third order aberrations.

12. The apparatus of claim 10, further including a polarizing filter through which said reflected point source image of said retina passes prior to being received by said means for receiving said reflected point source.

13. A method for fabricating contact lenses to correct at least the third order wave aberrations of the living eye, comprising the steps of:

generating a reflected point source image of the retina of said living eye;

receiving said reflected point source image and converting said point source image to corresponding digital signals;

calculating wave aberrations of said eye so as to include at least third order modes, using said digital signals; and

receiving the calculated wave aberrations for fabricating at least one contact lens to provide wavefront compensation for said at least third order wave aberrations of said living eye.

14. The method of claim 13, further including the step of polarizing said reflected point source image to remove stray light reflected from the cornea of said living eye prior to receiving said reflected point source image.

15. A method for determining the wave aberrations of the living eye using a wavefront sensor which receives a reflected point source image of the retina of said eye, comprising the steps of:

providing a plurality of lenslets which form a lenslet array for receiving said

reflected point source image of said retina, said lenslet array being configured such that it is capable of providing resolution for at least fifth order aberrations;

receiving an aerial image of the retinal point source formed on each of said plurality of lenslets of said lenslet array and generating signals representative thereof; and

converting said signals to digital signals representative of said retinal point source aerial images, and calculating wave aberrations of said eye so as to include at least fifth order modes, using said representative digital signals.

16. The method of claim 15, further including the step of polarizing said reflected point source image to remove stray light reflected from the cornea of said living eye prior to said plurality of lenslets receiving said reflected point source image.

17. A method for determining the wave aberrations of the living eye using a wavefront sensor which receives a reflected point source image of the retina of said eye, comprising the steps of:

providing a plurality of lenslets which form a lenslet array for receiving said reflected point source image of said retina, said lenslet array being configured such that it is capable of providing resolution for at least third order aberrations;

receiving an aerial image of the retinal point source formed on each of said plurality of lenslets of said lenslet array and generating signals representative thereof;

converting said signals to digital signals representative of said retinal point source aerial images, and calculating wave aberrations of said eye so as to include at least third order modes, using said representative digital signals; and

adjusting a compensating optical device to provide wavefront compensation for said wave aberrations of said living eye using said calculated at least third order wave aberrations of said living eye.

18. Apparatus for generating high resolution images of the retina of the living eye, comprising:

means for generating a reflected point source image of the retina of said living eye;

means for receiving said reflected point source image and for converting said point source image to corresponding digital signals;

a digital data processor for calculating said at least third order wave aberrations using said digital signals;

means for illuminating a retinal disk on said living eye for producing a retinal disk image;

a compensating optical device for reflecting said retinal disk image, said compensating optical device being adjusted using said calculated wave aberrations such that wavefront compensation for said wave aberrations is provided for said living eye; and

means for providing an image of said reflected retinal disk image after its reflection by said compensating optical device.

19. The apparatus of claim 18, wherein said compensating optical device is one of a deformable mirror, liquid crystal device, micro-machined mirror and bimorph mirror.

20. The apparatus of claim 18, further including a polarizer through which said reflected point source image of said retina passes prior to being received by said plurality of lenslets.

21. The apparatus of claim 18, wherein said means for generating comprises a plurality of lenslets which form a lenslet array for receiving said reflected point source image of said retina, said lenslet array being configured such that it is capable of providing resolution for at least third order aberrations.

22. An optical instrument which incorporates a wavefront sensor for determining the wave aberrations of the living eye, said wavefront sensor receiving a reflected point source image of the retina of said eye, comprising:

a plurality of lenslets which form a lenslet array for receiving said reflected point source image of said retina and for creating an aerial image of the retinal point source; said lenslet array being configured such that it is capable of providing resolution for at least fifth order aberrations;

a camera located adjacent to said lenslet array for viewing said aerial image of the retinal point source formed on each of said plurality of lenslets of said lenslet array; and

a digital data processor connected to receive video output signals from said camera and for converting said video output signals to digital signals representative of said retinal point source aerial images, said digital data processor further calculating the wave aberrations of said eye so as to include at least third order modes, using said representative

digital signals, such that improved vision results when said living eye utilizes said optical instrument.

23. A method for generating high resolution images of the retina of the living eye, comprising the steps of:

generating a reflected point source image of the retina of said living eye;  
receiving said reflected point source image and for converting said point source image to corresponding digital signals;  
calculating said at least third order wave aberrations using said digital signals;  
illuminating a retinal disk on said living eye for producing a retinal disk image; and  
reflecting said retinal disk image on a compensating optical device, said compensating optical device being adjusted such that wavefront compensation for said wave aberrations is provided for said living eye.

24. The method of claim 23, further including the step of polarizing said reflected point source image to remove stray light reflected from the cornea of said living eye prior to receiving said reflected point source image.

25. Apparatus for generating high resolution images of the retina of the living eye, comprising:

means for determining at least a third order wave aberration of said living eye and for generating a correction signal representative thereof;



a compensating optical device for reflecting an image of said retina and for receiving said correction signal, said compensating optical device being adjusted using said correction signal such that wavefront compensation for said at least third order wave aberration is provided for said living eye; and

means for providing said high resolution image of said retina after its reflection by said compensating optical device.

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